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ABSTRACT

The principal sociological frameworks used in energy research on developing countries can be appraised in terms of the view of the energy-rural development problem that each framework implies. "Socio-Technical Analysis," which is used most in industrial and organizational sociology and in ecological anthropology, is oriented to the decomposition of production processes into discrete components. There has been little use of the "Diffusion Framework" in researching energy-rural development questions because there is uncertainty about how the energy problem can be stated in terms compatible with a diffusion perspective. The Dependency Framework views the energy question as an element of the international economic system and the energy-rural development issues as part of the dynamics of underdevelopment. Application of the "Social Impact Analysis," which is the utilization of an eclectic mix of elements from other frameworks, works best when it operates on the basis of some social theory which guides its focus. Since it considers both energy and social systems, the "Ecological Approach" is preferred for social research on energy and rural development. Because it is suspected that the real challenge of the energy crisis is "completely social" (social ability to anticipate, learn, manage, and organize) and because success in energy conservation and non-conventional energy generation programs must be measured ultimately against the broader dynamics of poverty, it is believed that social scientists have a responsibility to approach the problem from the perspective of overcoming poverty. (CM)

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SOCIOLOGICAL PERSPECTIVES ON ENERGY AND RURAL DEVELOPMENT:

A REVIEW OF MAJOR FRAMEWORKS FOR RESEARCH ON DEVELOPING COUNTRIES

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SOCIOLOGICAL PERSPECTIVES ON ENERGY AND RURAL DEVELOPMENT: A REVIEW OF MAJOR FRAMEWORKS FOR RESEARCH ON DEVELOPING COUNTRIES

INTRODUCTION

Broader awareness of the energy trap to which most societies have become vulnerable has peaked in recent years for obvious reasons. Dramatic escalations in prices and shortages in supplies of hydrocarbon products and heightened concern for the exhaustibility of improperly managed renewable resources have combined to create a periodic sense of "crisis" in some sectors of industrial societies. While some work on the American food system has pointed to its high energy intensity [Pimental et. al., 1973; Steinhart and Steinhart, 1974; Desai, 1977; Buttel, 1979] and recent agenda for basic agricultural research reflect sensitivity to petroleum dependence problems [Oyer,1976;NAS,1977;Wittwer,1978] others have suggested that in biomass productivity terms the American agricultural system is highly efficient [Pasour and Bullock,1977; Revelle,1979] and that agricultural energy problems are not serious because agricultural production represents only 3% of the nation's energy bill. Less affluent countries are much closer to the margin in meeting even basic human needs for significant proportions of their populations; they are much more heavily reliant on agriculture to generate income and employment in rural areas and to satisfy the often competing requirements for food and foreign exchange [Lappe and Collins,1977], and demographic and organizational problems often seriously amplify the consequences of other difficulties. In these countries the energy crisis is less a shock than a perversion. The energy dilemma is not so much a trap as a blind alley. Over a generation, strategies to improve agricultural productivity and develop viable modes of non-agricultural rural employment have barely kept pace with population growth [ADB,1977]. The

energy blind alley is that the technological, economic and institutional assumptions of those strategies may only be sustainable at increasingly higher costs in terms of financial support, regressive social impacts and future flexibility.

> Stated another way, today's farmers will require access to significantly greater real financial resources than now to use their current practices in the future. This, at the same time that agriculture will need to dramatically increase its productivity and larger numbers of rural landless will require inexpensive basic foods. If the scenario is even generally accurate, then rural inequalities would be magnified and a downward spiraling of the food-poverty syndrome stimulated. The development of more efficient plants would modify the scenario somewhat, but that modification might be offset by the effects of increasing population pressure and low growth of real wage rates [Koppel,1978a:3].

For many countries, a range of very complex energy policy questions are in varying stages of engagement. Most of these questions are beyond the scope of this paper, but a general awareness of their content will be assumed. What will be discussed here is the following issue: What frameworks should sociologists be using to understand the energy-rural development interface, especially in developing countries? Our purpose is to stimulate discussion which avoids some of the faddishness which accompanied the initial recognition of environmental questions by sociologists and, more importantly, to encourage discussion which confronts many of the crucial uncertainties which characterize the social significance of energy issues. We are committed to discussions of those uncertainties with colleagues throughout Asia and the U.S. as part of the work of the Resource Systems Institute and the Asia-Pacific Energy Studies Consortium on energy and rural development [RSI,1978;1979a;1979b]. In what follows, we are presenting our own view. It is a view which at once calls for a

more thorough understanding of the complexities of energy issues and a demystification of the social content of those issues. It is also a view which is couched in policy-oriented terms.

THE PROBLEM IS STATING THE PROBLEM

Determining an appropriate analytical framework is a decision which reflects the central vision of the problem demanding analysis. For energy and rural development, that is a key starting point. If we review work done to date, the outlines of several visions can be discerned. However, before discussing these in any detail, it is valuable to characterize some common attributes of existing work on developing countries. The following critical conclusions can be drawn:

1). The work is overwhelmingly energy assessment. It is only occasionally oriented to contemporary agricultural development issues or to a broader conception of rural development as an integrated and complex process.

2). The work is predominantly aggregative in analytical style. This is a result, in part, of severe data constraints, but it is also a consequence of assuming all energy sources and uses can be reduced to single indices such as kilocalories without significantly distorting efficiency considerations. Aggregation masks the variability that efficiency and quality criteria would reveal.

3). The work is characterized by a tendency toward heroic

generalizations in the advocacy of alternate energy systems. While these can be explained in part by very limited data, it also suggests a very interesting assumption: that rural social systems are very homogeneous with only moderate ranges of variability in energy uses. We believe the assumption is quite remarkable given the variability--not to mention the interaction--among agronomic, climatic, and hydrologic factors; cropping systems and cropping intensities; access to markets; patterns of access to productive assets; composition, distribution, and growth rate of population; farming scale; rural transportation and communication systems; urban impacts on labor markets; etc.

4). With few exceptions, in considering policy options the choices are seen as technological though the impacts are social. This is not a criticism of an answer, but of the predominance of the question which yields that answer and precludes others, namely: What social changes are necessary to accomodate technological solutions to energy problems?

5). Rural sociologists and other social scientists in general concerned with rural development have taken, at best, a backseat in conceiving, implementing and analyzing rural energy related research. Amulya Reddy's work at Bangalore and the Modern and Traditional

Technologies Project under the aegis of the United Nations University are two exceptions. The more common situation parallels a basic institutional reality: it is not the rural development or agricultural research agencies that are in the rural energy policy arena. Whether or not there really is a rural energy policy arena, it is the recently created energy ministries that are engaging in explicit discussions of energy issues for rural areas.

Despite this rather unsatisfactory overall picture, however, several more positive characterizations of work on the social aspects of energy and rural development in developing countries can also be stated:

1) There is an increasing tendency, although still a minority one, to locate the rural energy question within the food-poverty syndrome [Revelle, 1978;UNU,1979;NRC,1979;RSI,1978].
2) There is an emerging concern to moderate some of the more spectacular alarmist assumptions which have motivated much rural energy research [Makhijani and Poole,1975;Weingart,1979b].
3) There is increasing attention to the wide variation in rural energy mixes and rural energy end-uses [Tyers and Revelle,1978;Bhatia,1977;Desai,1978].

Our discussion now turns to a closer examination of the principal sociological frameworks which are represented, in one version or another, in existing work or appear as strong candidates for utilization in prospective

work. Each framework will be appraised in terms of the vision of the energy-rural development problem that it implies.

SOCIO-TECHNICAL ANALYSIS

This framework, which has received its fullest exposition in industrial sociology, organizational sociology and ecological anthropology, is oriented to the decomposition of production processes into discrete components. Analysis focuses on the interrelationships of organizational, managerial, and technological process characteristics. Its application to rural energy analysis has been accelerated by the popularity of the "flow" metaphor as an approach to understanding energy-rural development interactions. As we will point out later, the flow metaphor used here is a simplified version of the ecological flow metaphor. In the socio-technical analytical framework, energy flows do not necessarily occur in a functionally integrated or holistically conceived system. Research concentrates instead on chains of agricultural and household energy uses. Characteristics of energy uses for each task or technological component are examined with a possible expansion of inquiry to include the organization or management of that task or group of tasks. Socio-technical analysis can provide a basis for translating characteristics of technological processes into social terms. Examples are research on cooking functions [IER,1978], crop drying,[1] and biological pest control.[2] The problem in allowing social decomposition to replicate technological decomposition as an approach to understanding the social content of energy interactions is the problem of missing the forest for the trees. The larger social milieu is only present to the degree that technological components are in the analysis which elicit a broad selection of slices from particular social realities. That leaves a reductionist

vision of a social system, one in which the system exists only within a technological line-item energy account. Beyond the order supplied by the reconstitution of technological parts into some process, the social system does not really exist.

DIFFUSION

The employment of this framework for energy-rural development questions has been very thin. There appears to be some uncertainty about how the energy problem can be stated in terms compatible with a diffusion perspective. Several approaches to this issue have been attempted. Marchetti [1978] has studied the time frame and adoption pattern for large scale changes in technology systems. This approach has been of special interest to those examining large scale conversions to decentralized solar thermal and photovoltaic electricity generating systems and widespread applications of biogas and biomass related energy technologies [EPRI,1978;Buffington,1977; Prasithrathsint et al.,1979;Weingart,1979a]. The major limitation of the approach stems from an inadequate understanding of historical patterns of energy utilization and change in rural areas to support extrapolation from the current baseline or to develop scenarios outlining probable future states. Very often, diffusion studies focus on the adoption patterns of particular technological devices rather than patterns of overall technology unitilization or energy utilization in rural areas.

Another diffusion approach to the energy-rural development problem is a continuing tradition of anthropological and rural sociological research which can be broadly placed within the framework of Leslie White's energy and cultural development hypothesis [White,1943,1959;Spicer,1952;Cottrell, 1955;Shiels,1972;Adams,1975]. That hypothesis, which basically posits a

monotonic relationship between cultural complexity and aggregate energy consumption has motivated considerable research, but recent empirical work refutes the linear hypothesis [Rambo,1979]. The reevaluation of White's hypothesis should yield interesting research on the relationships between change in social scale and complexity and patterns and intensity of energy use. Anthropological and related rural sociological research has been muddled, however, by the strong tendency to assume that energy and technology are virtually synonymous. This is a familiar vision, but one which never quite comes to grips with the direct organizational significance of energy patterns as distinct from particular end-uses. Research related to firewood gathering might be the major exception [Islam, 1979].

A third type of diffusion research, one which sociologists have inadequately recognized, is the induced institutional innovation work summarized by Binswanger and Ruttan [1978] and sometimes called the "new" institutional economics [Ruttan and Hayami,1971;Alchian and Demsetz,1972; Davis and North, 1971;Williamson,1973;Roumasset,1974]. Recent work by Roumasset [1978] focuses on identifying "rational" changes in micro-level bargaining and contractual arrangements as the principal institutional impact categories resulting from shifts in factor prices, market accessibility and demographic factors. Barker [1978] has focused on the crucial requirement for land infrastructure such as irrigation to increase agricultural productivity. Irrigation can be an energy intensive technology as well as a vehicle for fuller utilization of community labor. Barker concludes that in attempting to determine how and at what rate responses to shifts from land to labor surplus will occur is difficult because of inadequate

understanding "as to what organizational and institutional changes are needed, and under the existing social structure, what can be accomplished." [Barker,1978:24]. That diffusion is driven by induced alterations in the incentive environment is not a new argument, but determining an optimal form of social organization as an explicit element of a response is a more recent proposal. The model has not been extensively or directly applied to energy-rural development issues, but it is reasonable to expect that such applications through factor price analyses will be forthcoming. The issue, among others, from a social perspective is whether this strong implicit assertion of an economic theory of energy value deprives energy of any direct social content. The social system appears as an aggregation of economic bargains struck largely in response to the relative costs of inputs to economic activities.

A fourth version of diffusion research on energy and rural development that will certainly expand is work involving the spread of particular energy patterns or technologies across whole social units. Buttel's [1979] work on the American states and the most developed capitalist societies [1977] is an illustration. This version of diffusion research can yield very good work on the social significance of energy questions, but to do so will require considerable effort at developing energy "variables" that can be socially interpreted in a comparative context.

It appears unlikely that diffusion research will, by itself, provide sufficient understanding of the social meaning of the energy-rural development interface. As an approach to comparative analysis and as a basis for stating and verifying a limited set of basic energy-social organization typologies, diffusion research can be very valuable. However,

the utility of the diffusion framework ultimately rests on the vision of "what" is diffusing and "what" if anything is being replaced, modified or recast. Without clarification of what it is about energy that should be significant for rural social organization, the diffusion framework operates at considerable disadvantage.

DEPENDENCY

This framework views the energy question as an element of the international economic system and therefore the energy-rural development issue as part of the dynamics of underdevelopment. Analyses of the "green revolution" and of food security generated within this framework focus on the inevitability of particular energy paths being imposed on developing countries [Lappe and Collins,1977;Levinson et al.,1977]. Research will tend to focus on modes of disengagement from that situation of constrained choice. The juxtaposition of appropriate technology research and the view that preferable energy futures for rural areas lie in self-contained village systems often occurs within the context of a dependency vision [Briscoe and Bari,1979]. As a mode of social analysis, the dependency framework stands the socio-technical analysis framework on its head by looking to class, political, and economic relations as the major factors determining energy choices. Where the utility of this framework may be limited is in the degree to which it underestimates the scope for choice that is present [Smith,1979] and confuses perverse consequences for perverse intentions.

SOCIAL IMPACT ANALYSIS

The application of this framework to energy-rural development issues is less the employment of a coherent framework and more the utilization of

an eclectic mix of elements from other frameworks in something approaching a methodological package. Social impact analysis works best when it operates on the basis of some social theory which guides its focus. Without that, it tends in practice to be oriented principally towards performance indicators at the expense of understanding underlying dynamics. The major utility of social impact analysis for rural energy issues is that it can generate, like ecological versions of diffusion research, sensitivity to correlations between energy patterns and important rural development performance indicators such as employment, health and income [Islam,1978]. Moreover, social impact analyses do tend to be understandable to policy makers. The problem here, as with the diffusion framework, is that without an adequate theory of energy and rural social systems, social impact analysis can do little more than monitor.

ECOLOGICAL APPROACHES

This is probably the leading candidate for pre-eminence in social research on energy and rural development, largely because it claims to draw from a paradigm that encompasses both energy and social systems. Within the ecological framework, "the aim of energy analysis is to quantify the energy flows inherent in all systems" [Gilliland,1977:1]. Those analyses can occur at micro and macro levels.

> Micro analyses are generally restricted to specific or limited numbers of processes, tasks or technologies. That is, they involve analyses of small systems which can be defined precisely....Who can disagree with the [objective of micro-ecological research, that is,] being able to compare the energy costs of various processes for producing the same product or service [Gilliland, 1977:2].

This leads to what has been called energy accounting, either through the intensive analyses of end-uses and energy mixes in small systems [Chatterjee,

1978] or analagous accounting in simplified large systems [Brookhaven National Laboratory,1978;Mubayi and Lee,1977a,1977b; Ramachandran and Gururaja,1977]. Where problems arise is in assigning quantitative energy values to non-physical inputs such as labor, organization or leadership, particularly in dealing with issues of second law efficiency in energy accounting.

At the macro level of ecological research, the issues are much more complex, because what is being constructed is an energy theory of value. The work of Howard Odum [1971] is the key formulation for most social scientists. Odum presents a holistic perspective which purports to explain interactions among matter, energy and money. Energy flow per unit of time (power) in an economy is the basic yardstick against which all social processes can be measured. Human value attributions ultimately follow energy costs. Odum's vision is a central pillar of the emerging science of ecological energetics. However, this is a science in which the dominating concepts are biological. The social science applications tend to share one of human ecology's major liabilities: an over-emphasis on the physical environment and man's adaptation to it rather than on man and his ability to create and change his environment [Mlinar and Teune,1978].

When applied to rural development, the ecological energetics framework results in analyses strongly framed around the accounting term, 'energy balance." This measure becomes the dominant criterion for evaluating the efficiency of alternative social arrangements [Phillipson,1966;Revelle,1979]. What is overlooked is that the measure is best suited to relatively simple natural ecosystems. Extension to large and complex social systems tends to be less an example of the attention to context which is supposed to make

ecological frameworks an advance over socio-technical analysis and more an illustration of just another form of energy reductionism [Rappaport,1968, 1971;Parrick,1969;Lee,1969]. Ecological energetics takes a necessary condition for a social system, a supportive environment for biological systems, and converts that into the determinant of optimal social systems. In small, isolated and relatively undifferentiated social systems, this may be defensible (though an analagous proposition might be that all history is caused by water). However, since most rural people do not live in small, isolated and relatively undifferentiated social units but rather participate in and are influenced by a range of intermediate social structures including intervillage systems, regions, social class, etc., the applicability of the ecological energetic framework for useful energy-rural development research would appear to be quite limited. At the minimum, what is required are ecological metaphors that are unambiguously social rather than biological.

Social ecology metaphors are available, which leads to the question of "ecotopia"--or an ecological utopia. If social scientists in the U.S. and Asia seek an ecotopia, i.e., the realization of relatively small and autonomous social systems, sustainable and resilient because of favorable energy balances and positive relationships with a renewable resource environment [Stivers,1976;Watt,et al.,1977;Revelle,1978], and able to satisfy basic material and social needs of their populations, they stand in very different positions from which to approach that ecotopia. U.S. rural society is part of an affluent, predominantly urban society. Agriculture is energy intensive and large scale; population pressure is low; the processing and distribution of agricultural products constitute a major component of the total food system; significant intermediate social

structures are present and strongly keyed to urban systems; and there is comparatively high occupational and residential mobility. Ecotopia is a "return", a disassembling of much existing social fabric. In developing this essentially revisionist strategy, key value and risk questions are:

-What quality of life standards can we maintain?

-What quality of life goals will need to be changed, dropped or added?

-How will impacts be distributed?

-Through what processes and within which time frames can such a strategy be implemented?

Between Indonesia, Bangladesh and the Philippines there is wide variability, but there are some common differences with the U.S. Whereas considerable attention in the U.S. is oriented toward a greater utilization of renewable resources, rural systems in developing Asia are in danger of excessive dependence on such resources [Tyers and Revelle,1978]. For many regions and for some countries, the consumption of commercial fuel in rural areas is negligible; but there is growing evidence that damage to the recovery capabilities of natural ecosystems through overexploitation of fuelwood reserves is certainly not negligible (e.g.,in the Nepalese Terai). In Asia, it is estimated that 0.79×10^9 cubic meters of fuelwood were consumed in 1974. It would require 1.25 billion barrels of oil per year to provide an equivalent amount of energy [Siddiqi,1979]. In many areas of Bangladesh, biomass production principally needed for food is also the main source of household fuel requirements [Forest Research Institute,1979]. Affluence is present, but in highly concentrated forms creating patterns of dualism in which, for example, the absence of adequate linkages between

rural and urban economies blocks the development of positive employment and income externalities even when productivity is growing [ADB,1977]. Rural areas are characterized by high population pressure and narrowly structured access to income, employment and food producing resources [ILO,1978]. Intermediate social structures exist, but they are often segmented. While some middle-sized cities and service centers play developmental roles for their hinterlands, in many instances they are more akin to vacuum cleaners than cornucopias in their relationship to surrounding rural areas [Koppel,1979b]. A number of observers [IBRD,1976;IFPRI,1976, 1977] now look to food shortages in the region in the mid-1980's in terms that recall the perspectives of the mid-1960's. Whereas ecotopia in the American case has been characterized as a "return" to a more energy efficient and ecologically sound rural development strategy, the transition to ecotopia for LDC's is a "realization"--an attainment of stable and continuing ability to satisfy basic social and material needs. In developing a realization strategy, key value and risk questions are:

- -How can different approaches to satisfying basic food needs be developed and implemented at the same time that even maintaining marginal performance capabilities is under pressure?
- -How much institutional and social "invention" will be required?
- -How much time will be needed to see effects from institutional and technological fixes relative to prospective weakening capacity to meet basic needs?

-How vulnerable are realization strategies in poor countries to major diversion by climatic variability, political and economic disturbances, and social breakdowns?

The discussions of paths to ecotopia are replete with technological and social fixes, both of which suffer from oversimplification of problems and solutions. However, it would seem clear that the paths vary widely with different sets of assessment issues involved. This is not an argument against the universality of certain social questions, but against the presumption of equivalent priorities and meanings of ecological energetic concepts for comparative analytical purposes. Actually, the strong contextual orientation of ecological energetics denies the possibility of comparative social analysis except through the reductionism of energy accounting. Use of terms such as resilience, sustainability or carrying capacity does not, by itself, introduce new social content into rural development analyses. It does introduce what are probably very important questions, but we would contend that sociology is not without some heritage of addressing such questions. Issues of integration and adaptation are key elements of theoretical and empiracal work on social change. We fail to understand why the energy issue should mandate a new language, when what is needed is better understanding of processes of social organization and social change, a continuing concern of sociology. Proponents of bio-energetics and related ecological models would argue that the ecological metaphor provides the broadest calculus for translating energy into social content, i.e., the organization of the ecosystem. The problem is that the calculus operates by doing the reverse: translating the organization of the ecosystem, including social systems,

into energy terms. With that step, the application of physical and biological "laws" to explain "social" change is logical.

If ecological frameworks are to be the principal candidate for social analysis of energy and rural development, then two caveats should be entered:

1) Sociologists should not assume that the meaning of energy is obscure or esoteric; that is precisely the starting point for socially trivial insights or ultimately excessive compromise with energetic reductionism. Interactions in rural social systems are complex and multifaceted. The social significance of those interactions should be understood, not obscured.

2) Biological metaphors cannot be transferred to the social sciences completely free of teleogical brands of functional assumptions and confusion between irreversibilities in a physical system (ecodisaster) and loss of capability to maintain direction (social disorganization).

VISIONS AND AGENDA

Whatever vision one chooses to hold of the significance of energy for rural social systems is less important than the one common question that all the visions share: What are the capabilities of rural social institutions to respond--and how--to altered accessibility to important resources? We beleive excessive debate on which paradigms to apply in pursuing this question may well be a hindrance to understanding until there are more coherent statements of what is "unique" and what is most crucial in social

terms about energy or energy-derived issues. In the meantime, an agenda for research can be identified which touches those aspects of both energy and rural development that will certainly require better understanding if such statements are to be forthcoming. The list that follows is illustrative of areas requiring continuing research effort:

1) The social organization of agriculture and the social organization of food systems.
2) Employment and unemployment in rural areas, occupational differentiation and occupational mobility, and non-agricultural enterprise development.
3) Intervillage and regional social systems, rural transport systems, secondary and tertiary urban centers, sociogenic factors to migration behavior.
4) Risk and resource allocation in multi-crop farming systems and multi-occupational households.
5) Interrelationships between social change and social indicators.
6) Sociological modelling at both micro and macro levels to develop propositions about systematic interactions among the numerous endogenous and exogenous change processes that might be operating in a society during a given time period.

There is another set of topic areas which have largely escaped the attention of rural sociologists and which seem to have particular relevance to energy and rural development research:

1). The social organization of research-innovation systems. While there has been research within the dependency framework on the international aspects of technology choice in developing countries, more detailed understanding of how the research-innovation process operates in different countries and for different technology areas with relevance to rural development is needed.

2). Energy indexing. In part, this is a technical problem of converting energy in its many forms into a common set of metrics and end-use categories for comparing consumption levels, efficiencies, etc. in a variety of social, ecological and technological settings. However, it also involves other more complex issues, since some would express the combined technological, institutional and cultural embodiments of energy uses in some single index as well. In some ways, these questions are not foreign to many sociologists and anthropologists who have noted that energy consumption levels are generally highly correlated with technology, urbanization, and social complexity. Our plea is for a clearer focus on energy, independent of the particular technological embodiments of energy.

In addition to the substantive orientation of needed research, there are some methodological and operational priorities which should be identified:

1) Historical studies of patterns in energy and rural development. This is a major gap and a very difficult one to fill. Even contemporary data are not available for most countries. However, careful agro-economic and social research, making creative use of existing secondary statistical and discursive data coupled with oral histories, should make it possible to generate at least the outlines of energy mix and consumption patterns in some localities. Until we have this type of record and are able to show its relation to rural socio-economic change, it will remain very difficult to develop adequate theory or to engage in meaningful projections. Sociologists trained in techniques of community studies should be able to take some leads in initiating this sort of research.

2) Studies designed to distinguish the independent effects of energy source, technological utilization, access to technology and fuels, and broader social patterns on energy mixes and end-uses. Existing village level studies tend to lump these

together with sampling attention possibly paid to some index of social class. This should be supplemented by more ambitious sampling designed to ensure adequate variation is present on the aforementioned dimensions. Research on structural effects is one model, but a more common one is represented by a good deal of the research conducted by industrial sociologists and those interested in interactions between technology and social organization. In many rural areas, a group of inter-village systems can provide the needed environment for this type of research [Koppel,1978a].

3) Normative forecasting as a tool to identify probable transition problems. Rural sociologists have not been inclined to use normative forecasting and similar techniques, in part because sociological theory in general really does not support such excercises. Despite that, it would appear to be very valuable to generate scenarios of developmental conditions at some future point, say 20 years, on the basis of different paradigms of social organization and social change. The understanding of energy from within that paradigm can be employed to set one of the major scenario parameters. Analysis would then work backwards

> to the transitional paths, probabilities and problems a system would face in moving from current institutional arrangements to that pattern of organization which, from the paradigm's perspective, would be most appropriate for the conditions stated for the future. This type of exercise can be very helpful in exposing crucial uncertainties and in locating issues that require much further clarification. The point of the analysis should be theoretical clarification rather than the advocacy of alternate scenarios [Freeman and Jahoda,1978]. In the absence of historical data on energy and rural development, this approach may be all the more important. Developing commercialization strategies for renewable energy sources that are consistent with social equity goals is an illustration of the type of prospective energy policy problem that might be better understood through the type of excercise being proposed here.

Our research suggestions are infused by a common assumption: while sociology, like other disciplines, will not provide an exhaustive insight into energy and rural development, that is all the more reason to be sure that the social content of energy and rural development is not diminished because of the premature readiness of sociologists to accept a form of technological determinism. Energy-rural development analysis without technological content would not be any better. The point is to develop

perspectives that appropriately reflect the social significance of energy-rural development interactions, in part by drawing upon the skills and accumulated experience available from the social sciences.

CONCLUSION

Our conclusion is a statement of orientation. The real crisis is not the worrisome energy futures which poor societies face, but the persistence of poverty itself. Success in energy conservation and non-conventional energy generation programs will be measured ultimately against the broader dynamics of poverty. Social scientists must be careful not to fall victim to the fallacies of decomposition and partial analyses that those concerned more directly with energy technologies consider necessary simplifications. We strongly suspect that the real challenge of the energy crisis is completely social: the ability of societies to anticipate, to learn, to manage, and to organize. The dynamics of poverty block those possibilities as much as resource crises place demands upon them. It follows that social scientists have an important responsibility to approach the energy-rural development issue from the perspective of overcoming poverty dynamics. This is not for ideological reasons alone but because any other focus of understanding will not address the heart of the development issue. Energy research that does not orient itself to that issue is not defusing any bombs; it is only lengthening some fuses.

NOTES

1. An example is the work on pyrolitic conversion being conducted by the Development Technology Center of the Bandung Institute of Technology (Indonesia) and by the Institute for Agricultural Engineering Technology at the University of the Philippines at Los Banos. See also Chancellor,1978.
2. An example is the research work on organizational approaches to biological pest control being conducted by the International Rice Research Institute under the coordination of Dr. Grace Goodell. That work is closely patterned after practices observed by IRRI staff members in Vietnam and China.

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